

## UNITED STATES PATENT OFFICE

2,527,230

METHOD OF CRYSTAL FORMATION AND  
PRECIPITATION

Vincent J. Schaefer, Schenectady, and Bernard  
Vonnegut, Alplaus, N. Y., assignors to General  
Electric Company, a corporation of New York

No Drawing. Application January 21, 1948,  
Serial No. 3,544

8 Claims. (Cl. 299—28)

1

This application is a continuation-in-part of our earlier application Serial No. 725,156, filed January 29, 1947, and later abandoned.

The present invention comprises a process whereby crystallization in whole or in part is caused in supersaturated vapor-containing gases and supercooled liquids. It relates in particular to the development of ice crystals in aerosols comprising supercooled water droplets, as, for example, supercooled natural atmospheric clouds in which snow crystals do not form even though the clouds have assumed a temperature below 0° C. and even as low as -35° C. or lower, for example, -38° C.

As a consequence of our invention, crystallization may be effected in supercooled liquids, or in gases containing a vapor which is supersaturated with respect to the solid state. For example, by means of our invention, ice crystals may be formed in a supercooled cloud or in an air mass supersaturated with regard to ice, or in supercooled liquids.

In accordance with our invention, foreign nuclei of definite crystalline structure are brought into contact with the supercooled or supersaturated component, e. g., supercooled liquids, supersaturated vapors, etc., which preferably should be at a temperature several degrees below the temperature at which the gaseous or liquid phase is in equilibrium with the solid phase. For example, in the case of supercooled water, e. g., supercooled water droplets, the temperature of the said supercooled water should preferably be at least as cold as about -4° C. or lower. The foreign nuclei which are introduced should have a space group and unit cell dimension similar to the solid form of the liquid or vapor which it is desired to crystallize.

For example, we have found that crystallization in whole or in part of a mass comprising supercooled droplets of water can be effected by the introduction of minute particles of silver iodide at a temperature of about -4° C. and below. In this case, the particle size of the silver iodide is of the range of from about 1 to 1000 microns. Smaller sizes of the silver iodide crystals are also effective for causing crystallization at temperatures below -4° C.

Thus, particles of silver iodide as small as 0.01 micron may advantageously be employed. In this smaller size range, it appears that the temperature at which these particles become active centers for crystallization is somewhat lower, for example, about -8° C., than that at which the

2

larger crystals of silver iodide will cause formation of ice crystals.

The foreign nuclei which are introduced into supersaturated air containing water vapor or clouds made up of minute droplets of supercooled water for the purpose of initiating crystallization preferably have a hemimorphic hexagonal crystalline structure similar to that of ice crystals. In particular, finely divided silver iodide and finely divided wurtzite (ZnS) have been found to be effective for this purpose. Various other minerals having the aforementioned crystalline structure may be similarly employed in a finely divided state to initiate crystallization, namely, zincite (ZnO), nephelite (NaAlSi<sub>3</sub>O<sub>8</sub>) and apatite [Ca<sub>5</sub>(FCl)Ca<sub>4</sub>(PO<sub>4</sub>)<sub>3</sub>].

One effective method of introducing silver iodide nuclei comprises feeding a string of combustible material, e. g., cotton, coated with silver iodide into a high temperature flame, for example, an oxyhydrogen torch. Simultaneously, a jet of compressed air is blown over the flame, without, however, extinguishing it, thereby cooling and diluting the gas containing volatilized silver iodide and resulting in the dispersion of extremely small silver iodide particles, e. g., as low as 0.01 micron in size, or smaller, in the aforementioned crystalline form.

We have found that the introduction of foreign nuclei of the designated crystalline structure, for example, silver iodide particles, may be varied. Thus, we have introduced silver iodide crystals directly into an atmosphere supersaturated with water vapor with respect to ice, thereby causing precipitation of the water as ice crystals. In another instance, we have found it useful to generate smokes comprising minute particles of silver iodide and introducing these smokes into the atmosphere outside the supersaturated region, whereby in the course of time these foreign nuclei eventually find their way into supersaturated atmospheres by virtue of natural mixing caused by movement of the atmosphere.

The present invention of causing the formation of crystals by the introduction of foreign nuclei possesses definite advantages over a process of introducing seed crystals of the component to be crystallized, e. g., ice crystals in the case of supercooled water. Sources of minute foreign nuclei suitable for causing crystallization can be stored and introduced under conditions adverse to the storage and introduction of crystals of the component to be crystallized. For example, if it should be desired to produce crystallization of a supercooled atmospheric cloud, it is possible to